therein rather than, or in addition to, a magnetic stripe. While these RFID cards and like have been found to be successful in preventing or limiting fraud, they are more difficult and expensive to manufacture relative to ordinary magnetic stripe cards. One of the biggest obstacles to the wide spread manufacture and use of RFID cards has been the inability of card manufacturers to manufacturer an RFID card that meets all industry standards and specifications, such as those set by the International Standards Organization (ISO), that are sufficiently aesthetically pleasing (wherein the embedded electronics are hidden from view), and that have a sufficiently regular or flat surface such that one or both surfaces of the card may be printed on using the very popular and widespread dye sublimation technology. Known plastic cards with computer chips and like embedded therein are too thick to work in connection with existing card reading machinery (ATM machines, telephones, and like) and have a surface that is too irregular to properly and consistently receive dye sublimation printing. Furthermore, prior attempts to manufacture a sufficiently thin plastic card including a computer chip embedded therein have resulted in a card with inferior aesthetic qualities such as the ability to see the embedded computer chip through the plastic.

Summary of the Invention

The present invention is therefore directed to a plastic card having at least one electronic element embedded therein and to a hot lamination method for the manufacture of plastic cards including at least one electronic element therein. The card has an overall thickness in the range of 0.028 inches to 0.032 inches and comprises a plastic core having at least one electronic element embedded therein with at least one of the upper and lower surfaces of the core comprising a coating printed or otherwise applied thereon. An overlaminate film is preferably provided over the coated surface of the core and the resulting card has a variation in thickness across the surfaces thereof of no greater than approximately 0.0005 inches. The hot lamination method of the present invention comprises the steps of providing first and second plastic core sheets, positioning at least one electronic element between the first and second core sheets to thus form a core, and placing the core in a laminator and closing the laminator without applying laminator ram pressure to the core. A heat cycle is applied to the core sheets in the laminator thus liquefying or partially liquefying the sheets. The laminator ram pressure is then increased in combination with the heat. A cooling cycle is then applied to the core in the laminator, preferably with an associated increase in ram pressure, and the core is

removed from the laminator. At least one surface of the core is then printed on using a printing press or similar printing apparatus, a sheet of overlaminate film is placed on at least one side of the core, and the core is then again placed in a laminator. A heat cycle is applied to the core with its overlaminate film, and a cooling cycle is thereafter applied, resulting in a sheet of plastic card stock from which one or more cards may be cut. The invention is also directed to a card manufactured in accordance with the above process which results in a plastic card having a thickness in the range of approximately 0.028 inches to 0.032 inches with a surface smoothness of at least approximately 0.0005 inches as is required by ISO and American National Standards Institute (ANSI) standards.

The present invention provides numerous advantages over known plastic cards and known plastic card manufacturing processes, including the formation of a plastic card with electronic elements such as a computer chip embedded therein with a pleasing aesthetic appearance, with a sufficiently smooth and regular surface such that the card may receive dye sublimation printing, and with sufficient durability and characteristics to comply with all industry specifications and standards.

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Brief Description of The Drawings

Fig. 1 is a top plan view of a plastic card in accordance with the present invention;

Fig. 2 is a side elevational view of the card shown in Fig. 1;

Figs. 3A-3C are top plan views of various electronic elements that may be embedded in a card in accordance with the present invention;

Fig. 4 is an exploded, schematic view of an electronic element position between two plastic core sheets to form a core;

Fig. 5 is a top plan view of a plurality of electronic elements positioned on a sheet of plastic core stock such that they may be covered by a similar sheet of core stock;

Fig. 6 is a schematic cross-sectional view of one or more electronic elements positioned between sheets of plastic core stock;

Fig. 7 schematically illustrates a book comprising the core, as it is positioned in a laminator apparatus;

Fig. 8 schematically illustrates the core as it is being printed on after removal from the laminator using a printing press or similar printing apparatus;

Fig. 9 is a cross-sectional view schematically illustrating the application of an overlaminate film to at least one side of the core;

Fig. 10 schematically illustrates the core with overlaminate film, as it is placed in a laminator for final processing to form a sheet of card stock.

Detailed Description of the Invention

The present invention relates to a plastic card including at least one electronic element embedded therein. The present invention also relates to a hot lamination process for the manufacture of plastic cards, and more particularly to a hot lamination process for the manufacturer of plastic cards that include an electronic element, such as a computer chip or other electronic element embedded therein. The electronic element may perform a wide variety of functions and take a wide variety of forms. Such cards, without regard to the particular electronic element embedded therein, will hereinafter be referred to as radio frequency identification (RFID) cards. The present invention also relates to a card formed in accordance with the invention.

Referring now to Fig. 1, there can be seen a plastic RFID card 10 manufactured in accordance with the present invention and including an electronic element 20 embedded therein. Card 10 includes an upper surface 12 and a lower surface 14. Electronic element 20 may take a wide variety of forms and perform a wide variety of functions. As shown

in Fig. 3A -3C respectively, electronic element 20, 20', 20" may be provided by a micro-chip 22 including a wire antenna 24 connected thereto, a micro-chip 22' and a circuit board antenna 24' , a read/write micro-chip 22" and a wire coil antenna 24", or any other suitable electronic element. These electronic elements 20, 20', 20" and their insertion into plastic cards is not new, however, the present invention provides a new hot lamination process for manufacturing plastic cards 10 with these electronic elements 20, 20', 20" embedded therein such that the cards 10 are of a superior quality, such that the cards 10 meet all ISO and other industry specifications and standards, in such that at least one of the upper and lower surfaces 12, 14 of card 10 is sufficiently smooth and is otherwise is capable of receiving dye sublimation printing. Specifically, a card in accordance with the present invention has a thickness of approximately in the range of 0.028 inches to 0.032 inches with a surface smoothness of 0.0005 inches.

As shown in Figs. 4-10 one or more cards 10 in accordance with the present invention may be manufactured by positioning an electronic element 20 between first and second sheets of card stock 30, 32 to form a core 33. Preferably is shown in Fig. 5-10, a plurality of cards are manufactured simultaneously, in thus, a plurality of

electronic elements 20 are positioned between the first and second sheets of plastic core stock 30, 32 (only the second sheet 32 begin shown in Fig. 5 for clarity). When a plurality of electronic elements 20 are positioned between first and second sheets plastic core stock 30, 32, electronic elements 20 are properly positioned relative to one another such that a plurality cards may be cut from the resulting card stock. Plastic core sheets 30, 32 may be provided by a wide variety of plastics, the preferred being polyvinyl chloride (PVC) having a thickness in the range of 0.007 inches to 0.024 inches and preferably having a thickness of approximately 0.0125 inches each. Those skilled in the art will recognize that the thickness of the plastic core sheets will depend upon the thickness of the one or more electronic elements that are to be embedded therebetween. Other suitable plastics that may be utilized include polyester, acrylonitrile-butadiene-styrene (ABS), and any other suitable plastic.

Subsequent to placing one or more electronic elements 20 between the first and second sheets 30, 32 of plastic core stock to form a core 33, this core 33 is placed in a laminator apparatus 40 of the type well known in the art of plastic card manufacturing. As is shown in Fig. 7, laminator 40 includes upper and lower platens 42,44 for applying ram pressure to an article positioned therebetween.

In addition to the ability to apply ram pressure, laminator 40 is preferably of the type having controlled platens 42,44 that may provide both heat and chill cycles and preferably includes cycle timer to regulate cycle time. Core 33 is positioned between first and second laminating plates 50, 52, one of which is preferably matte finished to provide laminated core 33 with at least one textured outer surface. First and second laminating pads 60, 62 are positioned outside of the laminating plates 50, 52, and first and second steel plates 70, 72 are likewise positioned outside of pads of 60, 62 and the entire assembly forms a book ~~35~~ 37 for being positioned in laminator 40 between platens 42, 44.

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Once book ~~35~~ 37 is positioned in laminator 40 as shown in Fig. 7, the first lamination cycle is initiated by closing laminator platens 42, 44, preferably applying little or no ram pressure to book ~~35~~ 37. A laminator heat cycle is initiated, bringing the temperature of platens 42,44 up to a range of 275ºF to 400ºF, and most preferably up to a range of 300ºF to 370ºF for a period of greater than 5 minutes, and preferably in the range of 7 to 10 minutes. Once the heat cycle has been applied to the book 35 as is set forth above, the ram pressure of laminator 40 is increased to facilitate the flow of the plastic core sheets 30, 32 so that the one or more electronic elements 20 are encapsulated there by, and so that sheets 30, 32 form a uniform core 33

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(seen most clearly in Figs. 8-10) with upper and lower surfaces 34,35. As mentioned, the use of matte finished laminator plates 50,52 provides surfaces 34,35 with a slightly roughened or textured quality which will facilitate the application of a coating thereto as is discussed below. The ram pressure applied during the heat cycle and the length of the heat cycle may vary, depending especially upon the size of sheets 30, 32. For example, the cycle time may be in the range of 10-15 minutes. In one example, a ram pressure of 940.135 pounds per square inch (p.s.i.) was applied for 10-15 minutes to form a uniform core 33, using sheets 30,32 of a size in the range of 12 inches by 24 inches to 24 inches by 36 inches.

Subsequent to the above heat cycle, laminator 40 applies a chill cycle to book 37 during which time the ram pressure of the laminator 40 is increased, preferably by approximately 25% until the platens 42,44 have cooled to approximately 40ºF to 65ºF for approximately 10-15 minutes. Core 33 may then be removed from laminator 40 for additional processing.

Subsequent to the removal of core 33 from laminator 40, and as illustrated in Fig.8, core 33 is coated on at least one of it's upper and lower surfaces 34, 35 with a layer of printing ink 36. This may be accomplished using a wide variety of printing techniques such as offset printing,

letterpress printing, screen printing, roller coating, spray printing, litho-printing, and other suitable printing techniques. As shown in Fig. 8, core 33 is fed in the direction indicated with arrow A through a printing press, a lithographic printer, or a similar apparatus 80. This printing step is performed to coat at least one surface 34, 35 of core 33 with a layer of aesthetically pleasing ink 36. This layer of ink 36 cosmetically hides the one or more electronic elements 20 that are embedded within core 33, and prevents these one or more electronic elements 20 from showing through the relatively thin core 33. In this manner, the one or more electronic elements 20 encapsulated in core 33 are completely hidden from view without requiring the plastic used in the manufacture core 33 to be excessively thick.

Referring now to Figs. 9-10, the final processing of core 33, which now comprises a layer of ink 36 or the like on at least one surface 34,35 thereof, is schematically illustrated. A layer of overlaminate film such as clear overlaminate film 38,39 is positioned on at least one ink coated surface 34,35 of core 33, and preferably core 33 is positioned between two similar sheets of overlaminate film 38,39 as shown. Overlaminate film is very thin, for example in the range of 0.0015" thick. A book 135 is then constructed for insertion into laminator 40 as is

schematically illustrated Fig. 10. Book 135 comprising core 33, including at least one layer of ink 36 and at least one layer of overlaminate film 38, 39 is positioned between laminating plates which are preferably highly polished plates such as mirror finished stainless steel plates 90, 92. Book 135 also comprises first and second laminating pads 60, 62 and first and second steel plates 70, 72 as is discussed above in relation to Fig. 7.

When book 135 is positioned between upper and lower platens 42,44 of laminator 40 as shown in Fig. 10, the laminator is closed and a heat cycle in the range of 175º F to 300º F, and most preferably in the range of 180ºF to 275ºF, is applied to book 135 for a period of 10 to 25 minutes with a ram pressure that varies depending upon sheet size or the ram size of the laminator 40, but which is typically approximately 1000 p.s.i. with an 18 inch diameter ram. The laminator 40 is then caused to execute a chill cycle, preferably with a corresponding increase in ram pressure. For example, the chill temperature may be in the range of 40º F to 65º F and last for a period of 10 to 25 minutes. A ram pressure increase of approximately 25% over the pressure used for the heat cycle has been found to be most preferable.

Subsequent to the above described second lamination cycle as illustrated in Fig. 10, a sheet of plastic card

stock is provided which comprises at least core 33 with at least one surface 34,35 thereof covered by a layer of ink 36, and with at least one surface 34,35 thereof covered by a layer of overlaminate film 38, 39. Preferably plastic card stock manufactured in accordance with the present invention comprises core 33 covered on both surfaces 34,35 with a layer of ink 36 which is positioned between layers of overlaminate film 38,39, all of which has been laminated together as described. One or more cards 10 then may be cut from the resulting plastic card stock and card 10 will have a thickness in the range of 0.028 inches to 0.032 inches with variation in overall thickness across the surfaces 12, 14 thereof being no greater than approximately 0.0005 inches. The one or more cards 10 can thus be said to have a surface smoothness of approximately 0.0005 inches or better. Thus, a card 10 manufactured in accordance with the present invention includes at least one surface 12,14 at preferably both surfaces 12,14 that are sufficiently smooth and regular to receive dye sublimation printing.

Those skilled in the art will recognize that the foregoing description has set forth the preferred embodiment of the invention in particular detail and it must be understood that numerous modifications, substitutions, and changes may be undertaken without departing from the true

spirit and scope of the present invention as defined by the ensuing claims.

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What is claimed is:

1. A hot lamination process for the manufacture of a plastic card, said process comprising the steps of:

(a) providing first and second plastic core sheets;

(b) positioning at least one electronic element between said first and second plastic core sheets to form a layered core;

(c) positioning said core in a laminator apparatus, heating said core in said laminator, thereafter applying ram pressure to said core such that said at one electronic element is encapsulated in said core, and thereafter cooling said core in conjunction with laminator ram pressure being applied to said core, said core including an upper and lower surfaces;

(d) printing on at least one of said upper and lower surfaces of said core such that a layer of ink is applied to said at least one upper and lower surface of said core;

(e) positioning said core in a laminator apparatus with a layer of overlaminate film on at least one of said upper and lower surfaces of said core and laminating said layer of overlaminate film to said core in said laminator to thereby form a sheet of plastic card stock; and,

(f) cutting at least one card from said sheet of plastic card stock.

2. A hot lamination process as recited in claim 1, wherein said step (c) of positioning said core in a laminator apparatus is carried out by positioning said core between first and second laminating plates, at least one of said first and second laminating plates having a matte finish to provide at least one of said upper and lower core surfaces with a correspondingly textured surface.

3. A hot lamination process as recited in claim 2, wherein each of said first and second laminating plates includes matte finish to provide both of said upper and lower surfaces of said core with a correspondingly textured surface.

4. A hot lamination process as recited in claim 1, wherein said first and second plastic core sheets are made from a material selected from the group consisting of polyvinyl chloride, polyester, and acrylonitrile-butadiene-styrene, wherein each of said sheets has a thickness in the range of 0.007 inches to 0.024 inches.

5. A hot lamination process as recited in claim 4, wherein said first and second plastic core sheets have a thickness of approximately 0.0125 inches.

6. A hot lamination process as recited in claim 1, wherein said step (c) is carried out by:

(c1) constructing a first book including said core and at least first and second laminating plates respectively adjacent to said upper and lower surfaces of said core ;

(c2) positioning said book in said laminator apparatus;

(c3) closing said laminator apparatus and heating said core for a first predetermined amount of time without applying essentially any laminator ram pressure to said core;

(c4) increasing said laminator ram pressure following the passage of said first predetermined amount of time to apply pressure to said core in conjunction with said heating of said core; and,

(c5) cooling said core in said laminator in conjunction with laminator ram pressure being applied to said core.

7. A hot lamination process as recited in claim 6, wherein said step (c5) is carried out with a ram pressure that is greater than the ram pressure utilized in step (c4).

8. A hot lamination process as recited in claim 7, wherein the laminator pressure utilized in step (c5) is at least approximately 25% greater than the ram pressure utilized in step (c4).

9. A hot lamination process as recited in step 6, wherein at least one of said first and second laminating plates is a matte finished laminating plate to provide at least one of said upper and lower surfaces of said core with a corresponding matte finish.

10. A hot lamination process as recited in claim 9, wherein both of said first and second laminating plates are matte finished laminating plates to provide each of said upper and lower surfaces of said core with a corresponding matte finish.

11. A hot lamination process as recited in claim 6, wherein said step (c3) is carried out by heating said core to a temperature in the range of 300°F to 370°F for at least 5 to 10 minutes.

12. A hot lamination process as recited in claim 11, wherein said step (c4) is carried out by increasing said laminator ram pressure to a pressure approximately in the range of 700 p.s.i. to 1000 p.s.i. for at least 10 minutes.

13. A hot lamination process as recited in claim 1, wherein said step (d) is carried out utilizing a printing press.

14. A hot lamination process as recited in claim 1, wherein said step (d) is carried out utilizing a coating techniques selected from the group consisting of silk screen printing, offset printing, letterpress printing, screen printing, roller coating, spray printing, and litho-printing.

15. A hot lamination process as recited in claim 1, wherein said step (e) is carried out by positioning said core between first and second sheets of overlaminate film such that a layer of overlaminate film is laminated to both said upper and lower surfaces of said core.

16. A hot lamination process as recited in claim 1, wherein said at least one electronic element is a micro-chip and an associated wire antenna.

17. A hot lamination process as recited in claim 1, wherein said at least one electronic element is a micro-chip and an associated circuit board antenna.

18. A hot lamination process as recited in claim 1, wherein said at least one electronic element is a read/write integrated chip and an associated antenna.

19. A hot lamination process as recited in claim 1, wherein said step (e) is carried out by positioning said core with said layer of overlaminate film in said laminator apparatus between first and second laminating plates, wherein at least one of said first and second laminating plates includes a highly polished surface in contact with said layer of overlaminate film.

20. A plastic card constructed in accordance with claim 1.

21. A plastic card comprising:

a plastic core including at least one electronic element embedded therein, said core having an upper surface and a lower surface;

a coating on at least one of said upper and lower surfaces; and,

a layer of overlaminate film positioned on said at least one coated surface, wherein said card has an overall thickness in the range of approximately 0.028 inches to 0.032 inches with a variation in overall thickness across the upper and lower surfaces being no greater than approximately 0.0005 inches.

22. A plastic card as recited in claim 21, wherein said core is made from a plastic selected from the group consisting of polyvinyl chloride, polyester, and acrylonitrile-butadiene-styrene

Express Mail Label No.

Docket No.
6014-1

Declaration and Power of Attorney For Patent Application

English Language Declaration

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

Radio Frequency Identification Card and Hot Lamination Process for the Manufacture of Radio Frequency Identification Cards

the specification of which

(check one)

☒ is attached hereto.

☐ was filed on _____ as United States Application No. or PCT International Application Number _____

and was amended on _____

(if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d) or Section 365(b) of any foreign application(s) for patent or inventor's certificate, or Section 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate or PCT International application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)			Priority Not Claimed
(Number)	(Country)	(Day/Month/Year Filed)	☐
(Number)	(Country)	(Day/Month/Year Filed)	☐
(Number)	(Country)	(Day/Month/Year Filed)	☐

I hereby claim the benefit under 35 U.S.C. Section 119(e) of any United States provisional application(s) listed below:

60/005,685	10/17/95
(Application Serial No.)	(Filing Date)
(Application Serial No.)	(Filing Date)
(Application Serial No.)	(Filing Date)

I hereby claim the benefit under 35 U. S. C. Section 120 of any United States application(s), or Section 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. Section 112. I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, C. F. R., Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application:

(Application Serial No.)	(Filing Date)	(Status) (patented, pending, abandoned)
(Application Serial No.)	(Filing Date)	(Status) (patented, pending, abandoned)
(Application Serial No.)	(Filing Date)	(Status) (patented, pending, abandoned)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

(6)

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. *(list name and registration number)*

Steven M. Haas , Reg. No. 37,841
Scott M. Oldham, Reg. No. 32,712
Mark A. Watkins, Reg. No. 33,813
Stephen L. Grant, Reg. No. 33,390
Craig E. Miller, Reg. No. 33,427
Louis F. Kreek, Reg. No. 17,241

Send Correspondence to: **Steven M. Haas**
Oldham & Oldham Co., L.P.A.
1225 West Market Street
Akron, OH 44313-7188

Direct Telephone Calls to: *(name and telephone number)*
Steven M. Haas (330) 864-5550

1-00

Full name of sole or first inventor **Keith R. Leighton**
Sole or first inventor's signature Keith R. Leighton — Date: **October 5, 1996**
Residence **Lorain, Ohio** OH
Citizenship **U.S.A.**
Post Office Address **2817 Fulmer Road, Lorain, Ohio 44053**

Full name of second inventor, if any
Second inventor's signature — Date
Residence
Citizenship
Post Office Address

VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY STATUS (37 CFR 1.9(f) AND 1.27 (b)) - INDEPENDENT INVENTOR	Docket No. 6014-1

Serial No.	Filing Date	Patent No.	Issue Date

MAIL ROOM OCT 2 1 1999 PAT. & TRADEMARK OFF.

Applicant/ Patentee: **LEIGHTON, Keith R.**

Invention: **Radio Frequency Identification Card and Hot Lamination Process for the Manufacture of Radio Frequency Identification Cards**

As a below named inventor, I hereby declare that I qualify as an independent inventor as defined in 37 CFR 1.9(c) for purposes of paying reduced fees under section 41(a) and (b) of Title 35, United States Code, to the Patent and Trademark Office with regard to the invention entitled above and described in:

- ☒ the specification to be filed herewith.
- ☐ the application identified above.
- ☐ the patent identified above.

I have not assigned, granted, conveyed or licensed and am under no obligation under contract or law to assign, grant, convey or license, any rights in the invention to any person who could not be classified as an independent inventor under 37 CFR 1.9(c) if that person had made the invention, or to any concern which would not qualify as a small business concern under 37 CFR 1.9(d) or a nonprofit organization under 37 CFR 1.9(e).

Each person, concern or organization to which I have assigned, granted, conveyed, or licensed or am under an obligation under contract or law to assign, grant, convey, or license any rights in the invention is listed below:

- ☒ No such person, concern or organization exists.
- ☐ Each such person, concern or organization is listed below.

*NOTE: Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities (37 CFR 1.27)

FULL NAME _____

ADDRESS _____

☐ Individual ☐ Small Business Concern ☐ Nonprofit Organization

FULL NAME _____

ADDRESS _____

☐ Individual ☐ Small Business Concern ☐ Nonprofit Organization

FULL NAME _____

ADDRESS _____

☐ Individual ☐ Small Business Concern ☐ Nonprofit Organization

FULL NAME _____

ADDRESS _____

☐ Individual ☐ Small Business Concern ☐ Nonprofit Organization

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

NAME OF INVENTOR Keith R. Leighton
SIGNATURE OF INVENTOR Keith R. Leighton DATE: October 5, 1996

NAME OF INVENTOR ____________
SIGNATURE OF INVENTOR ____________ DATE: ____________

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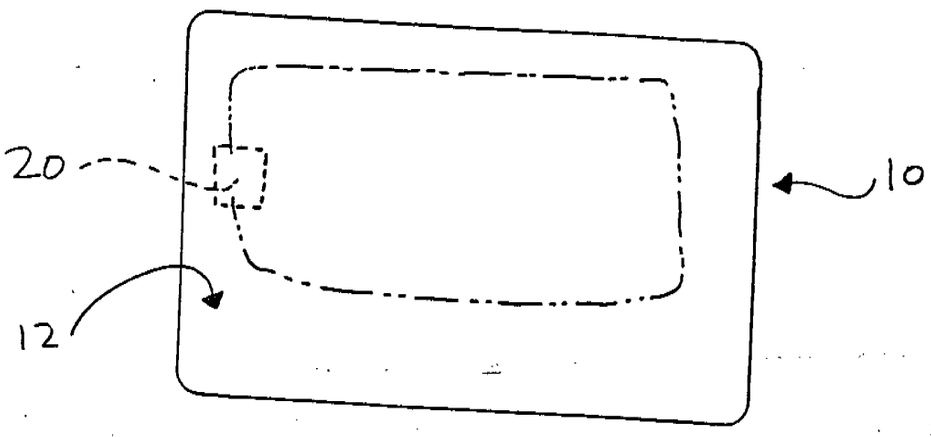

Fig. 1

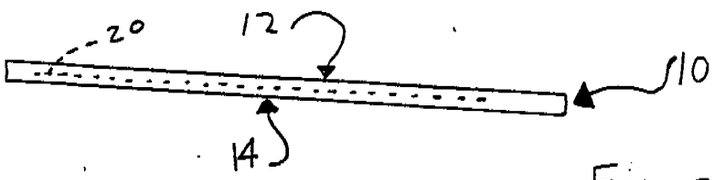

Fig. 2

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Fig. 3A

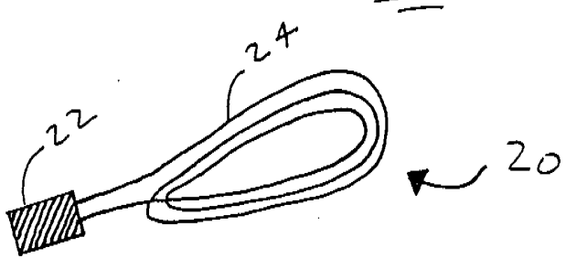
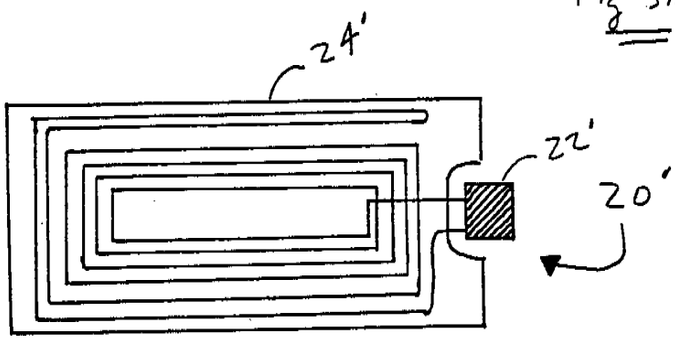


Fig 3B



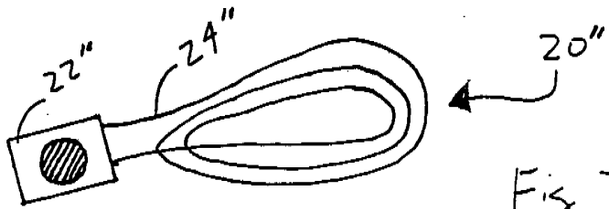


Fig 3C

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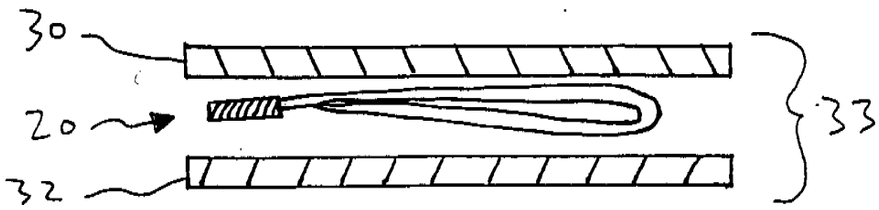

Fig 4

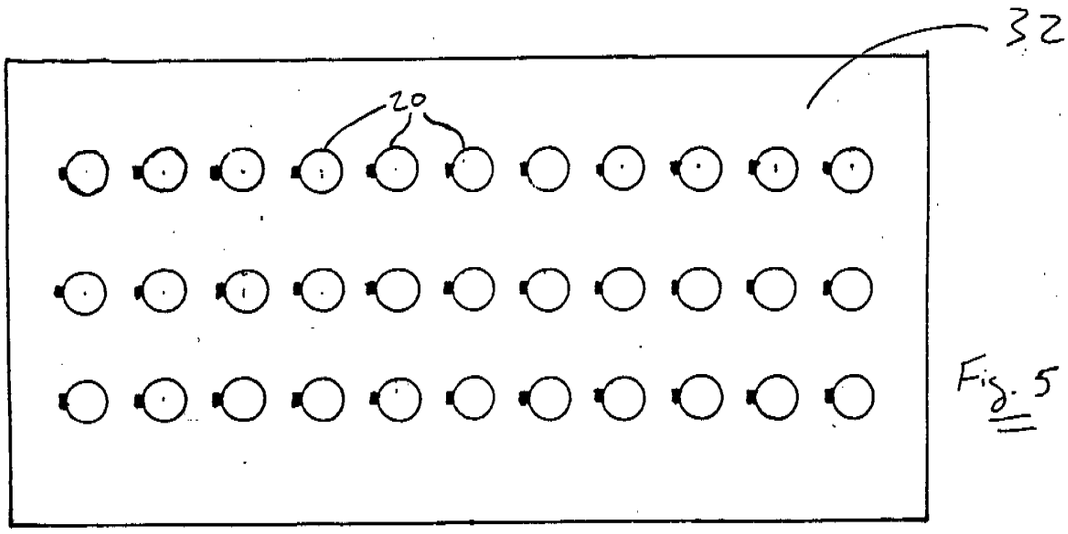

Fig. 5

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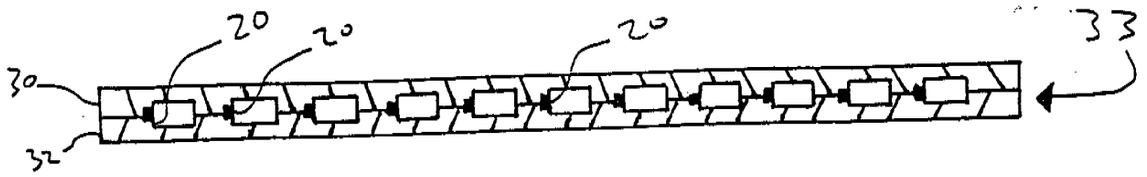

Fig 6

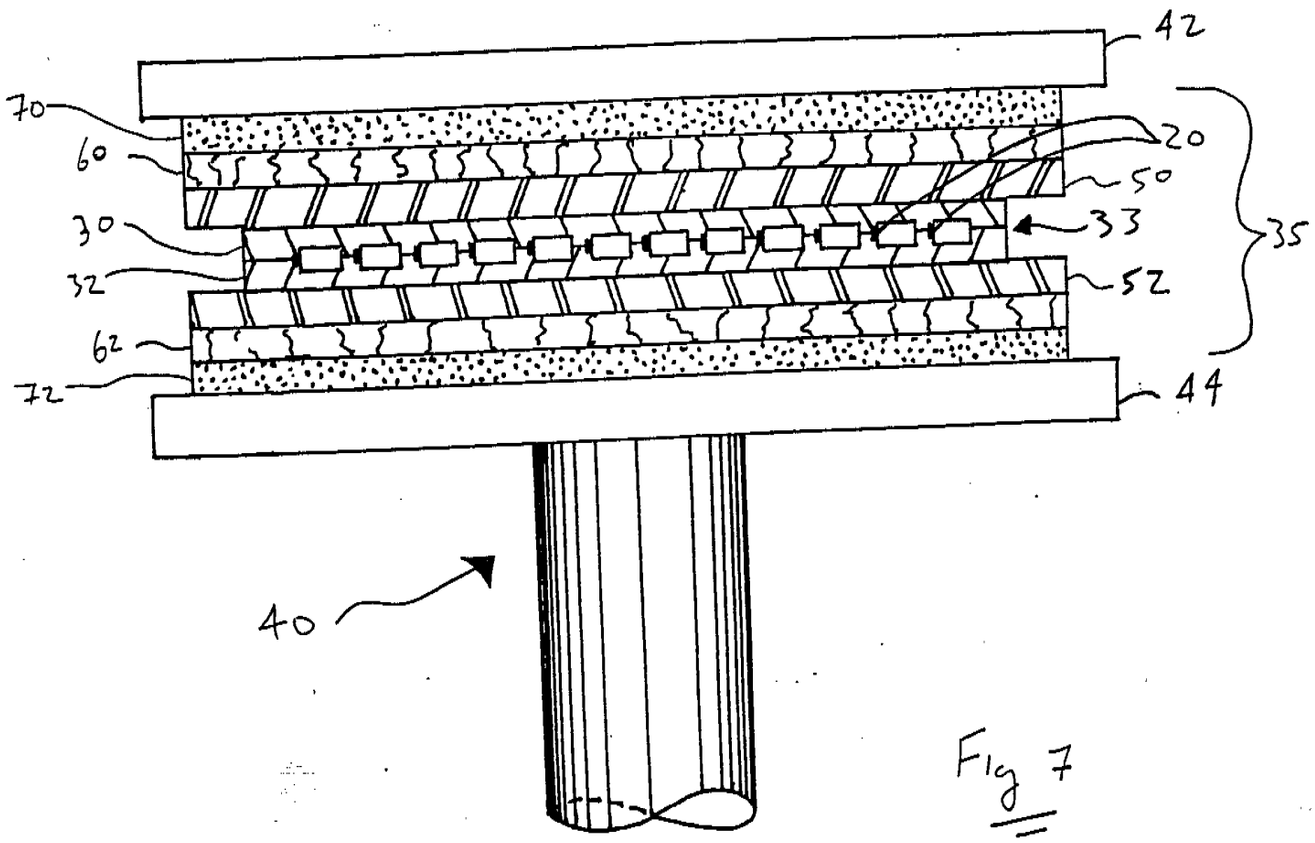

Fig 7

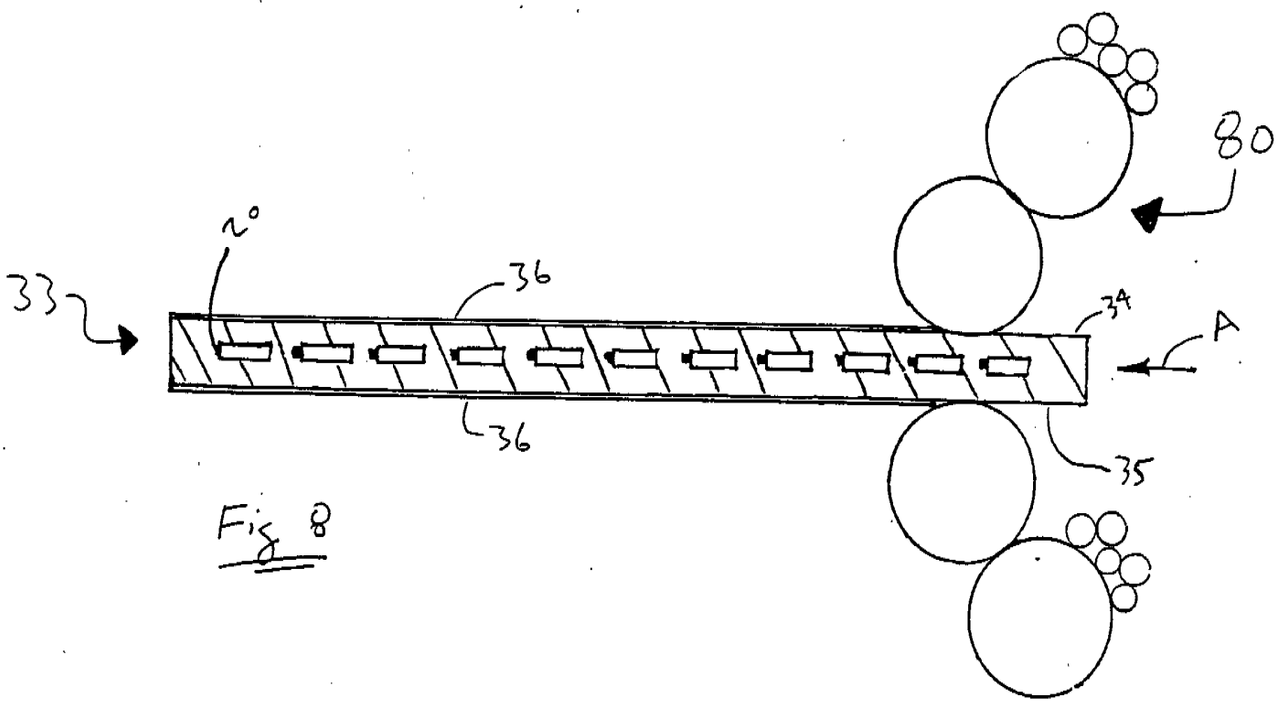

Fig 8

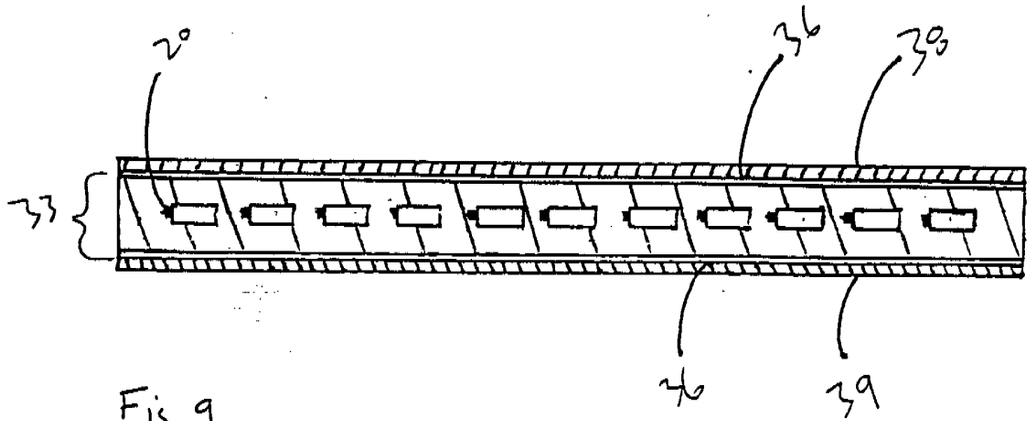

Fig 9